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Nutrient load compensations as a means of maintaining the good ecological status of surface waters

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Background and motivation

- **Water Framework Directive**
  - Good ecological status of surface waters by 2027 + no deterioration
  - Water bodies
  - Indicators, including nutrient loads

- Weser ruling in 2013
  - Objectives of WFD binding → deterioration in any of the indicators not allowed → new production causing water pollution not allowed
  - ➢ **Could nutrient load compensations be a solution?**
    - Nutrient reduction credits

➢ Ecological compensations for biodiversity
➢ Carbon credits for climate

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Case study:

In 2019 the Supreme Administrative Court refused an environmenal permit for a large pulp mill located on the shore of Lake Kallavesi in Kuopio, based on the Water Framework Directive → additional nutrient loading would likely risk the ecological status of the water body.

We use this case only as illustrative case for compensations.

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Lake Kallavesi – currently in good ecological status

- To achieve good ecological status with **90% probability**, P loading should be reduced by 35 kg/day
  - Pulp mill would increase P loading 20 kg/day → **7.3 t/year**
  - Total compensation of increased P loading needed
  - Point and nonpoint sources possible to provide credits

Probability of good total P status	Required compensation, kg P/day
90%	**20**
80%	13
70%	**0**

→ Lake Load Response (LLR) model with inputs from VEMALA

Supply: waste water treatment plants

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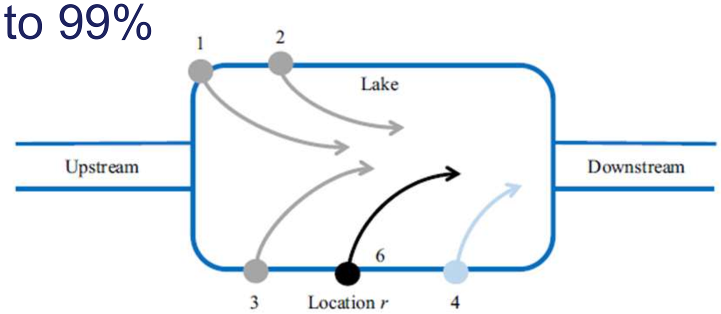
- 11 wastewater treatments plants: P abatement to 99%
  - Potential reduction only **0.6 t P/year**
  - Average cost 27-5000 €/kg P
  - Certain and permanent load reductions



- Due to hydrological processes, reduction in P at a WWTP does not mean an equal reduction from the pulp mill
  - **Delivery ratio**: share of one unit of load reduction at the source entering the target location (≤ 1) → with a ratio of 0.8, supply is 0.48 t P/year

- Also reductions in N load do have an effect → today focus only in P

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Supply: agriculture

- Fields from annual crops to long-term green fallow
  - Reduction **0.60 kg P/ha**
  - With delivery ratio 0.8 the reduction is 0.48 kg/ha
  - Uncertainties → **trade ratio** (> 1)
  - Payment of around 100 €/ha needed

- Potential:
  - Required area for total compensation 18 000 ha with trade ratio 1.2 and delivery ratio 0.8 → nonpoint sources alone enough
  - Average cost 167 €/kg P
  - Only annual reductions → we assume a 25-year contract with annual payments

Cost-efficient compensation

- 90% probability of good status
- Uncertainty trade ratio for nonpoint sources 1.2
- Delivery ratio 0.8 for all sources

Compensation source	Compensation, t P/year (area, 1000 ha)	Compensation cost, net present value, M€
WWTPs	0.5	0.20
Agriculture	8.3 (17)	31.0
Total	**8.8**	**31.2**

- Buy all available credits from WWTPs and the rest from agriculture
- Reducing the probability of good status to 80% reduces compensation cost to 19.7 M€

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Conclusions

- Compensation ecologically and economically feasible in this case study
  - Costs of buying compensations at most 2% of the planned investment cost of 1600 M€
  - But, allocating 17 000 ha of feed barley to green fallow reduces local feed supply around 62 million kg annually → increased demand for other feed sources for beef and milk production → risk of leakage
- Loading response assessment should always consider and report uncertainty
  - What is an acceptable risk level of not achieving a good status?
- Timing of nutrient load increase and decrease might differ
  - Additional trade ratio or a credit buffer?
- Nutrient load compensation currently not allowed in Finland → compensation would increase flexibility and cost-efficiency in achieving environmental goals

Thank you!

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